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TRANSMITTED HEREWITH FOR FILING IS THE PATENT APPLICATION OF
INVENTOR(S) Carl R. Lehfeldt, Christopher, and Charles Glorioso
FOR: TAMPER DETECTION MECHANISM

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ENCLOSED ARE:

- ☒ 10 PAGES SPECIFICATION, 42 CLAIMS (10 Pages), 1 SHEET ABSTRACT, 6 SHEETS INFORMAL DRAWINGS.
- ☒ DECLARATION AND POWER OF ATTORNEY
- ☒ AN ASSIGNMENT OF THE INVENTION TO Whisper Communications
- ☒ A VERIFIED STATEMENT TO ESTABLISH SMALL ENTITY STATUS UNDER 37 CFR 1.27
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John F. Schipper

John F. Schipper
Attorney of Record
Reg. No. 26,994
(408) 293-9934

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Applicant or Patentee: Carl Lehfeldt, Chris Waters and Charles GloriosoSerial or Patent No.: _____ Atty. Dkt. No.: 6013-002Filed or Issued: Filed herewithFor TAMPER DETECTION MECHANISM

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(37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

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☐ the owner of the small business concern identified below:☒ an official of the small business concern empowered to act on behalf of the concern identified below:NAME OF CONCERN WHISPER COMMUNICATIONSADDRESS OF CONCERN 3200 Coronado Drive, Santa Clara, California 95054

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled TAMPER DETECTION MECHANISM

by inventor(s) Carl Lehfeldt, Chris Waters and Charles Glorioso

described in

☒ the specification filed herewith☐ Application Serial No. _____, filed _____☐ Patent No. _____, issued _____

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). *NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any application any patent issuing thereon, or any patent to which this verified statement is directed.

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SIGNATURE _____

DATE 3/2/99

TAMPER DETECTION MECHANISM

Field of the Invention

This invention relates to detection of tampering with meters,
5 communication devices and similar devices.

Background of the Invention

As the cost of human intervention in reporting has increased,
automation of many of the reporting functions has become more attractive
in the commercial world. For example, the present meter values of many
10 electrical, gas, water, vehicle parking and similar meters can now be
electronically read and transmitted to a remote reporting station. As
another example, many burglar alarms, intrusion alarms, fire alarms,
environmental alarms and the like transmit alarm signals and all-clear
signals to a remote monitoring station.

15 A communication device, meter device and the like is referred to
collectively herein as a communications/meter device or "CMD". A
particular CMD may be inspected by a company representative once or a
few times per year, or more often or less often. In some instances, it is to
the advantage of the user of a CMD, or to one who would tamper with a
20 CMD, to interfere with normal operation of the CMD by arranging for
the CMD to report spurious values or conditions that do not accurately
represent the present use or environment of the CMD. In some instances, a
user of metered electricity, gas and/or water may attempt to tamper with
the associated meter for substantial time intervals by (1) turning the meter
25 off, by pulling all or a portion of the meter away from its normal
attachment site, or (2) reversing the meter direction so that a meter value
is caused to decrease, rather than increase, with continuing consumption of
the metered quantity. In other instances, an intruder, such as a burglar,
may attempt to tamper with an intrusion alarm to conceal the fact that this
30 person is present without authorization on some part of protected
premises.

What is needed is a system and associated method for detecting and
promptly reporting any of certain types of attempted tampering with a

CMD by sensing any of certain classes of movement of a CMD The system should operate automatically and should be capable of trouble-free operation, with little maintenance required, over long time intervals. The system should be capable of detecting attempted tampering with the CMD
5 itself and with the tamper detection system. Preferably, the system should allow retrofitting or inclusion with the original CMD equipment so that the system's presence and operation are not obvious to a CMD user. The system should be flexible enough to respond to different types of tampering attempts, and the cost of installing the system should be a small
10 fraction of the cost of the CMD. The system should allow tamper reporting at the CMD and/or of transmission of a tamper reporting signal to a remote reporting station.

Summary of the Invention

These needs are met by the invention, which uses magnetic,
15 electrical and/or mechanical responses by a tamper detection mechanism to monitor and report on attempts to rotate, translate or remove whatever attachment device (bolt, screw, etc.) are used to attach the meter to a CMD attachment site. In one embodiment, the invention uses one or more reed switches, oriented in a first preferred direction, and an adjacent permanent
20 magnet, oriented in a second preferred direction and attached to an attachment device, to detect attempted tampering with the CMD. An electrical current source is connected to a first end of the reed switch.

In one version of this embodiment, the reed switch is normally positioned in a closed state, allowing a small electrical current (or a
25 voltage) be sensed at a current-sensing (or voltage-sensing) device connected to a second end of the reed switch. If an attempt is made to rotate or translate the attachment device, the projection of the permanent magnet field at the reed switch changes sufficiently to cause the reed switch to open, thereby interfering with the current (or voltage) that
30 would otherwise be sensed and triggering a tamper alarm signal. In a second version of this embodiment, the reed switch is normally positioned in an open state, and a tamper alarm signal is triggered when the reed switch changes to a closed state.

In a second embodiment of the invention, a micro-switch and attached plunger are located adjacent to a CMD attachment device that has a small detent, or other surface irregularity against which the plunger is urged by a spring-like mechanism. Any attempt to rotate or translate the CMD attachment device causes the plunger to move longitudinally (in or out) from its normal location. Longitudinal movement of the plunger by more than a threshold amount causes the micro switch to generate a tamper alarm signal.

In a third embodiment of the invention, a first sector of a CMD attachment device is electrically conducting and a second (remaining) sector of the attachment device is non-conducting. Two terminals of a circuit, which includes a current or voltage source and includes a current sensor or a voltage sensor, are movably connected to the attachment device at spaced apart locations. When the attachment device is rotated, or alternatively translated, beyond a threshold amount, the portion of the attachment device between the two terminals transitions from conducting to non-conducting, or from non-conducting to conducting, and a tamper alarm signal is generated.

Brief Description of the Drawings

Figure 1 illustrates operation of a reed switch in the presence of a variable magnetic field.

Figure 2 is a schematic view of a first embodiment of the invention.

Figure 3 is a cutaway view showing important elements of the invention.

Figure 4 is a schematic view of a second embodiment of the invention.

Figures 5 and 6 are a longitudinal view and a side view of the attachment mechanism used in the second embodiment.

Figure 7 is a schematic view of a third embodiment of the invention.

Figures 8 and 9 are a longitudinal view and a side view of the attachment mechanism used in the third embodiment.

Description of Best Modes of the Invention

Figure 1 illustrates operation of a reed switch 11 in the presence of a magnetic field source 13, producing a magnetic field whose projection on a selected reed switch direction can change. Assume that the magnetic field **B** has an approximately constant magnitude $|\mathbf{B}|$ and that the angular orientation (θ) of the local magnetic field can change. With the angular orientation θ of the magnetic field in a first range, $\theta_1 < \theta < \theta_2$, or (optionally) in a second range, $\pi + \theta_1 < \theta < \pi + \theta_2$, the projection of the magnetic field **B**, on a reed switch unit length vector **D1** with a selected direction, has an amplitude (or, optionally, a magnitude) that is greater than a threshold projection value, and the reed switch is in a closed state. For many reed switches, the first range satisfies $\theta_2 - \theta_1 < \pi/2$ so that a rotation of the magnetic field vector **B** by less than $\pi/2$ will cause the reed switch 11 to change state. With the reed switch 11 in a closed state ($\theta_1 < \theta < \theta_2$), an electrical current source (or voltage source) 15, located at a first end of the reed switch, will cause a small electrical current (preferably nanoamps to microamps) to develop through the reed switch and be received by a current sensor (or voltage sensor) 17 that is located at or electrically connected to a second end of the reed switch.

With the reed switch in an open state, corresponding to the magnetic field angular orientation θ in a range $\theta_2 \leq \theta \leq \theta_3$, the end-to-end flow of electrical charge, produced by the electrical current source 13, is interrupted. Sensing of an open state of the reed switch 11, or, alternatively, sensing of a closed state of the reed switch ($\theta_1 < \theta < \theta_2$ and/or $\pi + \theta_1 < \theta < \pi + \theta_2$), may cause the sensor 17 to generate a tamper alarm signal. Practically speaking, it may be preferable to arrange for a closed reed state to generate an alarm signal, because the current is non-zero (and thus tends to deplete the current source) only in a non-normal (alarm) state. However, it is more difficult to extraneously produce a closed switch state, beginning with an open switch state, than in the inverse situation, and this difficulty may favor using the open switch state to generate an alarm signal. Operation of one type of reed switch is discussed

in U.S. Patent No. 4,663,601 (Figure 7, column 9) for a "Magnetic Switch Housing Assembly."

Figure 2 illustrates an embodiment of the invention. A reed switch 11, with a selected longitudinal direction vector **D1**, is hidden on or
 5 inconspicuously attached to a housing 21 of a CMD 19, near a housing aperture 23 that receives an attachment mechanism 25. The attachment mechanism 25 may be a bolt or screw, friction-generating nail or similar device that has a selected longitudinal direction vector **D2** and is used to attach the CMD 19 to a selected attachment site, such as a wall or other
 10 part of a stationary or movable structure (not shown in Figure 2). The attachment mechanism 25 may include a shank or shaft 27 and a broadened region 29 of the shank, with the broadened region having an aperture 31 therein. The shank aperture 31 receives a permanent magnet 13, inserted into the aperture and having an associated magnetic field vector **B**.
 15 Optionally, the attachment mechanism 25 also includes a washer 33 and/or a cap or fitting 35 that fits over the broadened region of the shank 27.

When the CMD housing 21 is attached to the selected attachment site, the attachment mechanism 25 is threaded or otherwise inserted through the housing aperture 23, and the direction of the magnetic field **B**
 20 is adjusted (by rotation of the attachment mechanism) so that the angle θ (Figure 1) between the vectors **B** and **D1** lies in a preferred angular range, $\theta_1 < \theta < \theta_2$ (or in the range $\pi + \theta_1 < \theta < \pi + \theta_2$), for which the reed switch 11 is in a closed state (or, alternatively, in an open state). A current or voltage source 15 and a current or voltage sensor 17 are attached to the
 25 reed switch 11 at first and second terminal locations, respectively, where the first and second locations are chosen so that these two locations are electrically connected only when the reed switch is in a closed state.

When the reed switch 11 is in a closed state, a small electrical current (preferably of the order of nanoamps or microamps) develops
 30 from the current source 15 through the reed switch to the current sensor 17; alternatively, a voltage is sensed at the voltage sensor 17. When the reed switch 11 is in an open state, no electrical current (or voltage) is sensed at the sensor 17 from the source 15. If the attachment mechanism

25 is rotated, in order to loosen the attachment mechanism or to remove the CMD 19, the direction of the magnetic field **B** produced by the permanent magnet 13 will also rotate, and the angle q will quickly move outside the range $\theta_1 < \theta < \theta_2$ (or outside the range $\pi + \theta_1 < \theta < \pi + \theta_2$), and
 5 the reed switch 11 will change from a first closed state to a second open state (or, alternatively, from a first open state to a second closed state). The sensor 17 senses this change in current (or voltage) from the source and generates an alarm signal, indicating that attempted tampering with the CMD 19 is being sensed. Optionally, a transmitter 41 and associated
 10 antenna 43, connected to or part of the sensor 17, are used to transmit an alarm signal to a reporting station for an appropriate response to the attempted tampering. As noted in the preceding discussion, an open state, or alternatively a closed state, for the reed switch can be chosen as the alarm condition, by appropriate configuring of the sensor 17.

15 As an alternative or supplementary condition, the distance d in Figure 1 between the permanent magnet 13 and the reed switch 11 can be chosen so that, when the attachment mechanism 25 is in its normal position, the projection of the magnetic field **B** on the direction **D1** at the reed switch satisfies a relation

$$20 \quad \mathbf{B} \cdot \mathbf{D1} = |\mathbf{B}| \cos\theta = B_{1\text{thr}} + \Delta B1, \quad (1)$$

where $\Delta B1$ is a small, positive or negative quantity ($|\Delta B1| \ll |\mathbf{B}|$) and $B_{1\text{thr}}$ is a threshold magnetic field value at which the reed switch 11 changes from a first switch state to a second switch state (or from a second switch state to a first switch state). The magnitude $|\mathbf{B}|$ will increase as the
 25 distance d between the permanent magnet 13 and the reed switch 11 decreases, and inversely. The sign of the quantity $\Delta B1$ is chosen so that, when the attachment mechanism 25 is translated along the direction of the vector **D2** in order to loosen or remove the attachment mechanism, the difference value $|\mathbf{B}| \cos\theta - B_{1\text{thr}}$ changes sign and the reed switch 11
 30 changes state. With this arrangement, translation of the attachment mechanism 25 along the parallel to the longitudinal direction vector **D2** by at least a selected threshold amount will produce a change in state of the reed switch and thereby generate an alarm signal, whether or not the

attachment mechanism is rotated about the longitudinal vector **D2**. Thus, translation and/or rotation of the attachment mechanism 25 can be sensed and used to detect attempted tampering with the CMD 19.

The permanent magnet may be any reasonable size that will allow
 5 insertion into the shank aperture 31 and will provide a magnetic field of sufficient magnitude at the adjacent reed switch 11. Two suitable size ranges for an oval-shaped or polygon-shaped permanent magnet are diameter 0.01-0.02 inches and length 0.04-0.06 inches. Suitable materials for the permanent magnet include aluminum-nickel-cobalt, iron-silicon,
 10 permalloy, Mn-Zn ferrite, iron-samarium and other rare earth-iron compounds. The magnetic field produced by the permanent magnet 13 is preferably about 15 amp-turns or greater.

Figure 3 is a cutaway view showing one arrangement for the first embodiment of the invention. The attachment mechanism 25 includes a
 15 threaded shank portion 27, a broadened shank portion 29, and an aperture 31 extending approximately transversely relative to a selected (longitudinal) attachment direction vector **D2**. Optionally, the attachment mechanism 25 includes a key portion 30 and/or an alignment aperture 32 that are used to align the permanent magnet 13 located in the attachment
 20 mechanism aperture 31. The reed switch 11 is preferably aligned so that an initial direction, or a rotated direction, of the magnetic field vector **B** is approximately perpendicular to a plane defined by the vectors **D1** and **D2**.

Although the first embodiment discussed in the preceding relies on a reed switch for its operation, any field-activated magnetic switch, such as a
 25 reed switch or a Hall effect switch, which manifests a first state or a second state, depending upon the direction of a local magnetic field vector relative to a selected switch direction, can be used for this embodiment. The switch portion of third embodiment of the invention is preferably arranged so that, in the first state and the second state of the field-activated
 30 magnetic switch, some portion of the switch is electrically conducting and electrically non-conducting, respectively.

Figure 4 illustrates a second embodiment of the invention. A micro switch 51 is attached to a housing 21 for a CMD 19 and is mechanically

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connected to a plunger 53 at one end of the plunger. The other end of the plunger 53 is received in an aperture 55 in the housing 21 and makes contact with a raised contact portion 57 of an attachment mechanism 59, such as a bolt, screw or the like, that is received in another aperture 61 in the housing 21. The plunger 53 is urged against the contact portion 57 of the attachment mechanism 59 by a spring-like or other suitable elastic force mechanism 63 that may be part of the micro switch 51. The attachment mechanism 59 and associated contact portion 57, shown in a longitudinal view in Figure 4, rotate together as a shaft or shank of the attachment mechanism rotates about a longitudinal direction vector **D2** in Figure 3.

As the attachment mechanism 59 rotates about a longitudinal direction **D2** in Figure 5, the raised contact portion 57 of the attachment mechanism 59 rotates and forces the plunger 53 to retract a controllable amount in the direction of the micro switch 51. Alternatively, as the attachment mechanism 59 rotates about the longitudinal direction **D2**, the raised contact portion 57 of the attachment mechanism 59 rotates and allows the plunger 53 to extend a controllable amount away from the micro switch 51. The micro switch 51 senses this motion of the plunger 53, interprets plunger movement by at least a selected threshold amount as an attempt to loosen or remove the attachment mechanism 59, or to remove the CMD 19 from its attachment site, and generates an alarm signal indicating that attempted tampering is occurring. The micro switch 51 can be arranged to sense, and thus generate an alarm signal for, movement by the plunger 53 by a threshold distance of less than the width of a knife edge, about 0.005 inches, or even smaller if desired. Preferably, the plunger threshold distance is not made so small that ordinary use or reading of the CMD will generate an alarm signal. Optionally, a transmitter 41 and associated antenna 43, connected to or part of the micro switch 51, are used to transmit an alarm signal to a reporting station for an appropriate response to the attempted tampering.

The raised contact portion 57 of the attachment mechanism 59, shown in a longitudinal or end view in Figure 5, is useful in sensing

whether the attachment mechanism has been rotated around its longitudinal axis (D2 direction). If the raised contact portion 57 is provided with a similar profile, with one or more diameter maxima in the longitudinal direction, illustrated in a side view in Figure 6, the system can also use
5 movement of the plunger 53 to sense whether the attachment mechanism 59 is being moved or translated in a longitudinal direction.

Figure 7 illustrates a third embodiment of the invention, in which an aperture 71 again receives an attachment mechanism (bolt, screw, friction-generating nail, etc.) 73. The attachment mechanism 73 includes a first
10 sector 73 A that is electrically conducting and a second (remaining) sector 73B that is electrically non-conducting. The two sectors 73A and 73B may be angular, as in Figure 8, or may be longitudinal, as in Figure 9. In one version of this embodiment, when the attachment mechanism 73 is seated in its intended position, first and second spaced apart locations on the
15 mechanism 73 make electrical contact with first and second electrical terminals 75A and 75B, respectively, of a circuit 77 that includes a current or voltage source 79 and includes a current sensor or voltage sensor 81. When the attachment mechanism 73 is correctly seated in the aperture 71, contact of the two terminals 75A and 75B with an electrically conducting
20 of the mechanism 73 produces an electrical current in the circuit 77 and at the sensor 81 (or produces a voltage across the sensor), which is interpreted as a no-tamper situation.

If the attachment mechanism 73 is rotated or translated by at least a threshold amount, the electrical current (or electrical voltage) is
25 interrupted because at least one of the two terminals 75A and 75B no longer makes contact with an electrically conducting portion of the mechanism 73. The sensor 81 interprets this interruption as an attempt to tamper with the attachment mechanism 73 and generates an alarm signal. Optionally, the alarm signal can be transmitted to a remote station using a
30 transmitter 83 and associated antenna 85 that are connected to, or are part of, the sensor 81.

Alternatively, the attachment mechanism 73 can be positioned so that: (1) at least one of the terminals 75A and 75B initially contacts an

electrically non-conducting portion of the mechanism 73, corresponding to a no-tamper situation; and (2) when the attachment mechanism 73 is rotated or translated by at least a threshold amount, the circuit becomes conducting, and an alarm signal is generated by the sensor 81.

5 Figure 8 is a longitudinal or end view of the attachment device 73, illustrating operation of the invention to sense rotation of the device 73. In a first version of the third embodiment, the first and second terminals 73A and 73B are initially positioned to provide an electrically conducting segment of the circuit across a sector 73A of the device 73 between the
10 two terminals 75A and 75B, and a current or voltage is sensed at the sensor 81 (Figure 7). When the attachment device 73 is rotated beyond a threshold amount, the circuit 77 becomes non-conducting, and an alarm signal is generated. In a second version of the third embodiment, the segment of the circuit between the terminals 73A and 73B is initially non-
15 conducting and becomes conducting when the attachment device 73 is rotated beyond a threshold amount.

 Figure 9 is a side view of the attachment device 73, illustrating operation of the invention to sense translation of the device 73. In a third version of the third embodiment, the first and second terminals 73A and
20 73B are initially positioned to provide an electrically conducting segment of the circuit along a sector 73A between the two terminals 75A and 75B, and a current or voltage is sensed at the sensor 81 (Figure 7). When the attachment device 73 is translated beyond a threshold amount, the circuit 77 becomes non-conducting, and an alarm signal is generated. In a fourth
25 version of the third embodiment, the segment of the circuit between the terminals 73A and 73B is initially non-conducting and becomes conducting when the attachment device 73 is translated beyond a threshold amount.

What is claimed is:

1. A system for detecting an unauthorized movement of a communications/meter device, the system comprising:

at least one device attachment mechanism, having a selected attachment direction, that attaches a communications/meter device to a selected attachment site;

a magnetic field source, associated with the attachment mechanism, that provides a first magnetic field with a first field direction and a second magnetic field with a second field direction when the attachment mechanism is in a first selected position and in a second selected position, respectively;

a field-activated magnetic switch, positioned adjacent to the attachment mechanism and arranged so that, when the first magnetic field is applied to the switch, the switch is in a first switch state, and when the second magnetic field is applied to the switch, the switch is in a second switch state, distinct from the first switch state; and

a switch sensor, connected to and sensing the state of the switch, that generates a selected alarm signal when the switch is not in the first switch state.

2. The system of claim 1, further comprising a signal transmitter, associated with said communications device, that transmits a selected signal when said field-activated magnetic switch is not in said first switch state.

3. The system of claim 1, wherein said second position of said attachment mechanism is selected from the group of positions consisting of: (i) rotation of said attachment mechanism about said attachment direction by at least a selected threshold angle, and (ii) translation of said attachment mechanism in said attachment direction by at least a selected threshold distance.

4. The system of claim 1, wherein said attachment mechanism at said first position provides a magnetic field, projected in a selected sensing direction, with a projected field magnitude that is at least equal to a selected magnitude threshold.

5. The system of claim 1, wherein said attachment mechanism at said first position provides a magnetic field, projected in said selected sensing direction, with a projected field magnitude that is less than said selected magnitude threshold.

6. The system of claim 1, wherein said switch sensor comprises:
at least one of an electrical current source and a voltage source, connected to said field-activated magnetic switch at a first selected location, that provides at least one of a current and a voltage at said switch, when said switch is in said first switch state; and
at least one of an electrical current sensor and a voltage sensor, connected to said field-activated magnetic switch at a second selected location, that senses a first level of current or voltage when said switch is in said first switch state and senses a second level of current or voltage when said switch is in said second switch state.

7. The system of claim 1, wherein said magnetic field source is a permanent magnet having a selected magnetic field direction and including a magnetic material drawn from a group of materials consisting of aluminum-nickel-cobalt, iron-cobalt, iron-silicon, iron-samarium, permalloy and Mn-Zn ferrite.

8. The system of claim 1, wherein said magnetic field source is a permanent magnet having a selected direction that is oriented at a selected orientation angle relative to a selected switch direction associated with said switch, when said switch is in said first switch state.

9. The system of claim 1, wherein said field-activated magnetic switch is drawn from a group of switches consisting of a reed switch and a Hall effect switch.

10. The system of claim 1, wherein said field-activated magnetic switch has an activation direction for change of state of said switch, and at least one of said first magnetic field direction and said second magnetic field direction is chosen to be approximately perpendicular to a plane defined by said attachment direction and the switch activation direction.

11. The system of claim 1, wherein said attachment mechanism is drawn from a group consisting of a bolt, a screw and a friction-generating nail, and said attachment direction is chosen to be approximately a longitudinal direction of a shaft of the bolt, screw or nail.

12. A method for detecting an unauthorized movement of a communications/meter device, the method comprising the steps of:

providing at least one device attachment mechanism, having a selected attachment direction, that attaches a communications/meter device to a selected attachment site;

providing a magnetic field source, associated with the attachment mechanism, that provides a first magnetic field with a first field direction and a second magnetic field with a second field direction when the attachment mechanism is in a first selected position and in a second selected position, respectively;

positioning a field-activated magnetic switch adjacent to the attachment mechanism and arranged so that, when the first magnetic field is applied to the switch, the switch is in a first switch state, and when the second magnetic field is applied to the switch, the switch is in a second switch state, distinct from the first switch state; and

generating a selected alarm signal when the switch is not in the first switch state.

13. The method of claim 12, further comprising the step of transmitting said alarm signal when said field-activated magnetic switch is not in said first switch state.

14. The method of claim 12, further comprising the step of selecting said second position of said attachment mechanism from the group of positions consisting of: (i) rotation of said attachment mechanism about said attachment direction by at least a selected threshold angle, and (ii) translation of said attachment mechanism in said attachment direction by at least a selected threshold distance.

15. The method of claim 12, further comprising the step of selecting said magnetic field source to provide, at said field-activated magnetic switch, a magnetic field with a projected field magnitude that is at least equal to a selected magnitude threshold.

16. The method of claim 12, further comprising the step of selecting said magnetic field source to provide, at said field-activated magnetic switch, a magnetic field with a projected field magnitude that is at least equal to a selected magnitude threshold.

17. The method of claim 12, further comprising the steps of:
providing at least one of an electrical current source and a voltage source, connected to said field-activated magnetic switch at a first selected location, that provides at least one of a current and a voltage at said switch, when said switch is in said first switch state; and

providing at least one of an electrical current sensor and a voltage sensor, connected to said field-activated magnetic switch at a second selected location, that senses a first level of current or voltage when said switch is in said first switch state and senses a second level of current or voltage when said switch is in said second switch state.

18. The method of claim 12, further comprising the step of selecting said magnetic field source to be a permanent magnet having a selected magnetic field direction and including a magnetic material drawn from a group of materials consisting of aluminum-nickel-cobalt, iron-cobalt, iron-silicon, iron-samarium, permalloy and Mn-Zn ferrite.

19. The method of claim 12, further comprising the step of selecting said magnetic field source to be a permanent magnet having a selected direction that is oriented at a selected orientation angle relative to a selected switch direction associated with said field-activated magnetic switch, when said switch is in said first switch state.

20. The method of claim 12, further comprising the step of selecting said field-activated magnetic switch from a group of switches consisting of a reed switch and a Hall effect switch.

21. The method of claim 12, wherein said field-activated magnetic switch has an activation direction for change of state of said switch, further comprising the step of choosing at least one of said first magnetic field direction and said second magnetic field direction to be approximately perpendicular to a plane defined by said attachment direction and the switch activation direction.

22. The method of claim 12, further comprising the step of selecting said attachment mechanism from a group consisting of a bolt, a screw and a friction-generating nail, and said attachment direction is chosen to be approximately a longitudinal direction of a shaft of the bolt, screw or nail.

23. A system for detecting an unauthorized movement of a communications/meter device, the system comprising:

at least one device attachment mechanism, having a selected attachment direction, that attaches a communications/meter device to a selected attachment site, the attachment mechanism having a contact

portion at a selected location that rotates as the attachment mechanism rotates about its attachment direction;

a plunger, having a selected plunger movement direction, that is urged against the attachment mechanism contact portion and that moves along the plunger movement direction as the attachment mechanism rotates about its attachment direction; and

a plunger movement sensor that senses plunger movement along the plunger movement direction and that generates an alarm signal when the plunger movement is greater than a selected movement threshold.

24. The system of claim 23, wherein said attachment mechanism contact portion comprises a raised portion of said attachment mechanism whose transverse diameter increases as said attachment mechanism is rotated through a selected angular range about said attachment direction.

25. The system of claim 23, wherein said plunger movement threshold is selected to correspond to the group of attachment mechanism positions consisting of: (i) rotation of said attachment mechanism about said attachment direction by at least a selected threshold angle, and (ii) translation of said attachment mechanism in said attachment direction by at least a selected threshold distance.

26. The system of claim 23, further comprising a signal transmitter, associated with said communications device, that transmits a selected signal when said plunger movement is greater than said selected threshold..

27. The system of claim 23, wherein said attachment mechanism is drawn from a group consisting of a bolt, a screw and a friction-generating nail, and said attachment direction is chosen to be approximately a longitudinal direction of a shaft of the bolt, screw or nail.

28. A method for detecting an unauthorized movement of a communications/meter device, the method comprising the steps of:

providing at least one device attachment mechanism, having a selected attachment direction, that attaches a communications/meter device to a selected attachment site, the attachment mechanism having a contact portion at a selected location that rotates as the attachment mechanism rotates about its attachment direction;

positioning a plunger, having a selected plunger movement direction, that is urged against the attachment mechanism contact portion and that moves along the plunger movement direction as the attachment mechanism rotates about its attachment direction; and

providing a plunger movement sensor that senses plunger movement along the plunger movement direction and that generates an alarm signal when the plunger movement is greater than a selected movement threshold.

29. The method of claim 28, further comprising the step of selecting said attachment mechanism contact portion to include a raised portion of said attachment mechanism whose transverse diameter increases as said attachment mechanism is rotated through a selected angular range about said attachment direction.

30. The method of claim 28, further comprising the step of selecting said plunger movement threshold to correspond to the group of attachment mechanism positions consisting of: (i) rotation of said attachment mechanism about said attachment direction by at least a selected threshold angle, and (ii) translation of said attachment mechanism in said attachment direction by at least a selected threshold distance.

31. The method of claim 28, further comprising the step of transmitting a selected signal when said plunger movement is greater than said selected threshold..

32. The method of claim 28, further comprising the step of drawing said attachment mechanism from a group consisting of a bolt, a screw and a friction-generating nail, and choosing said attachment direction to be approximately a longitudinal direction of a shaft of the bolt, screw or nail.

33. A system for detecting an unauthorized movement of a communications/meter device, the system comprising:

at least one device attachment mechanism, having a selected attachment direction, that attaches a communications/meter device to a selected attachment site, the attachment mechanism having a first sector and a second sector that are electrically conducting and non-conducting, respectively;

an electrical circuit, including at least one of a source of current and a source of voltage, that is electrically connected to the attachment mechanism at two spaced apart terminals, where the two terminals are both connected to the conducting sector when the attachment mechanism is in a selected first position, and at least one of the two terminals is connected to the non-conducting sector, when the attachment mechanism is in a second selected position; and

a sensor of at least one of current and voltage, connected to the circuit, that generates an alarm signal when at least one of the following conditions occurs: (1) the sensed current is in a first selected range and (2) the voltage is in a selected second range.

34. The system of claim 33, wherein said sensed current is in said first selected range when (i) said attachment mechanism is rotated about said attachment direction by at least a selected threshold angle or (ii) said attachment mechanism is translated in said attachment direction by at least a selected threshold distance.

35. The system of claim 33, wherein said sensed voltage is in said second selected range when (i) said attachment mechanism is rotated about said attachment direction by at least a selected threshold angle or (ii) said

attachment mechanism is translated in said attachment direction by at least a selected threshold distance.

36. The system of claim 33, further comprising a signal transmitter, associated with said communications device, that transmits a selected signal when said at least one of: said current is in said first selected range and said voltage is in said second selected range.

37. The system of claim 33, wherein said attachment mechanism is drawn from a group consisting of a bolt, a screw and a friction-generating nail, and said attachment direction is chosen to be approximately a longitudinal direction of a shaft of the bolt, screw or nail.

38. A method for detecting an unauthorized movement of a communications/meter device, the method comprising the steps of:

providing at least one device attachment mechanism, having a selected attachment direction, that attaches a communications/meter device to a selected attachment site, the attachment mechanism having a first sector and a second sector that are electrically conducting and non-conducting, respectively;

positioning an electrical circuit, including at least one of a source of current and a source of voltage, so that the circuit is electrically connected to the attachment mechanism at two spaced apart terminals, where the two terminals are both connected to the conducting sector when the attachment mechanism is in a selected first position, and at least one of the two terminals is connected to the non-conducting sector, when the attachment mechanism is in a second selected position; and

providing a sensor of at least one of current and voltage, connected to the circuit, that generates an alarm signal when at least one of the following conditions occurs: (1) the sensed current is in a first selected range and (2) the voltage is in a selected second range.

39. The method of claim 38, further comprising the step of arranging for said sensed current to be in said first selected range when (i) said attachment mechanism is rotated about said attachment direction by at least a selected threshold angle or (ii) said attachment mechanism is translated in said attachment direction by at least a selected threshold distance.

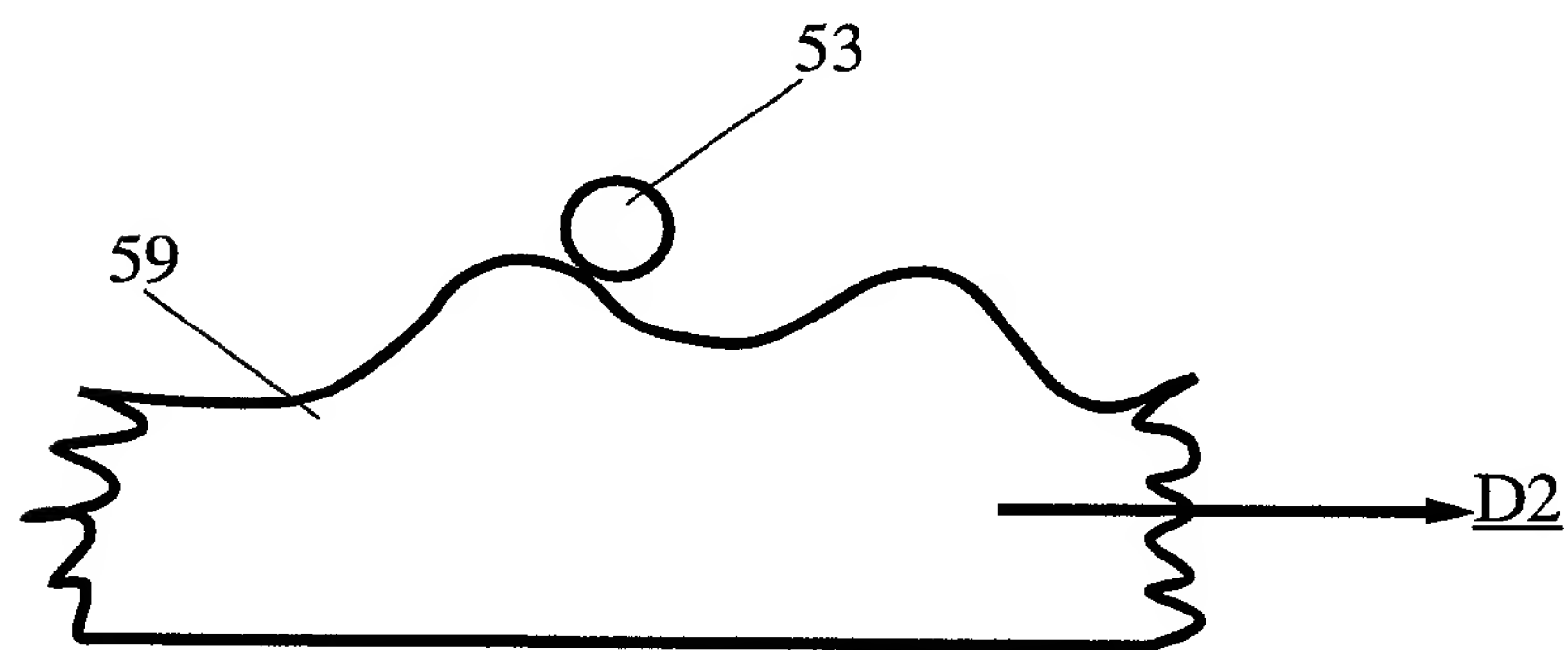
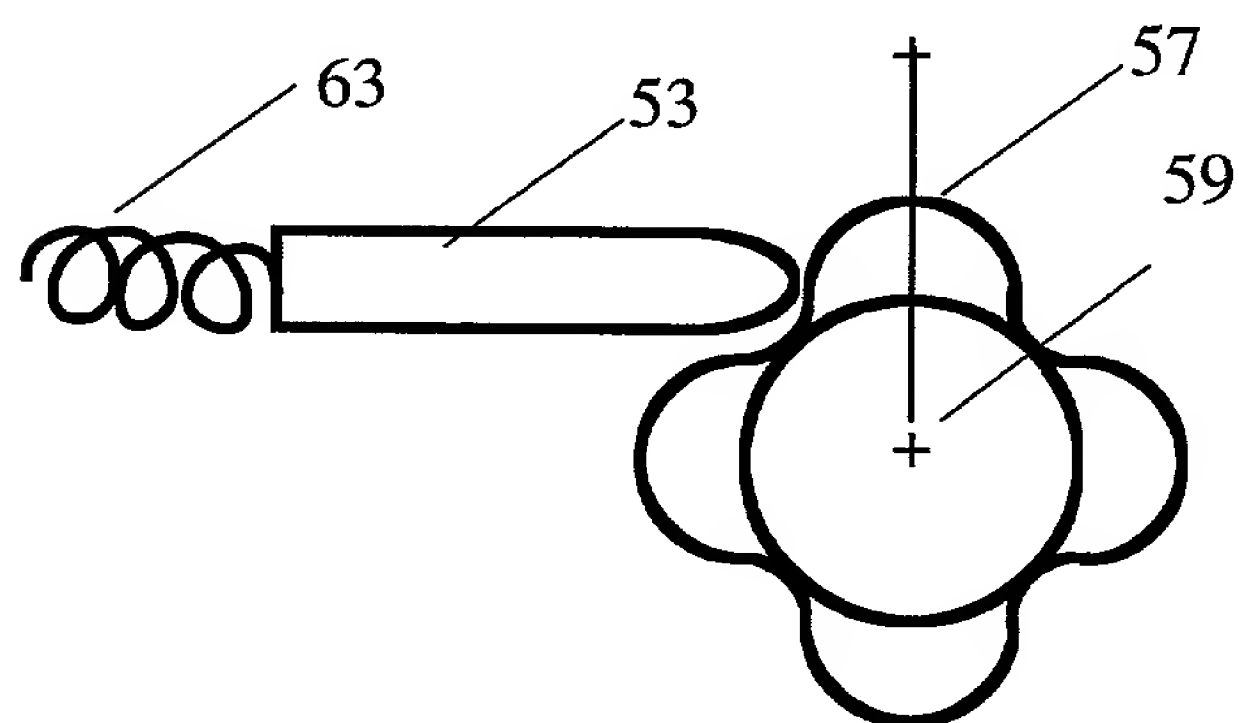
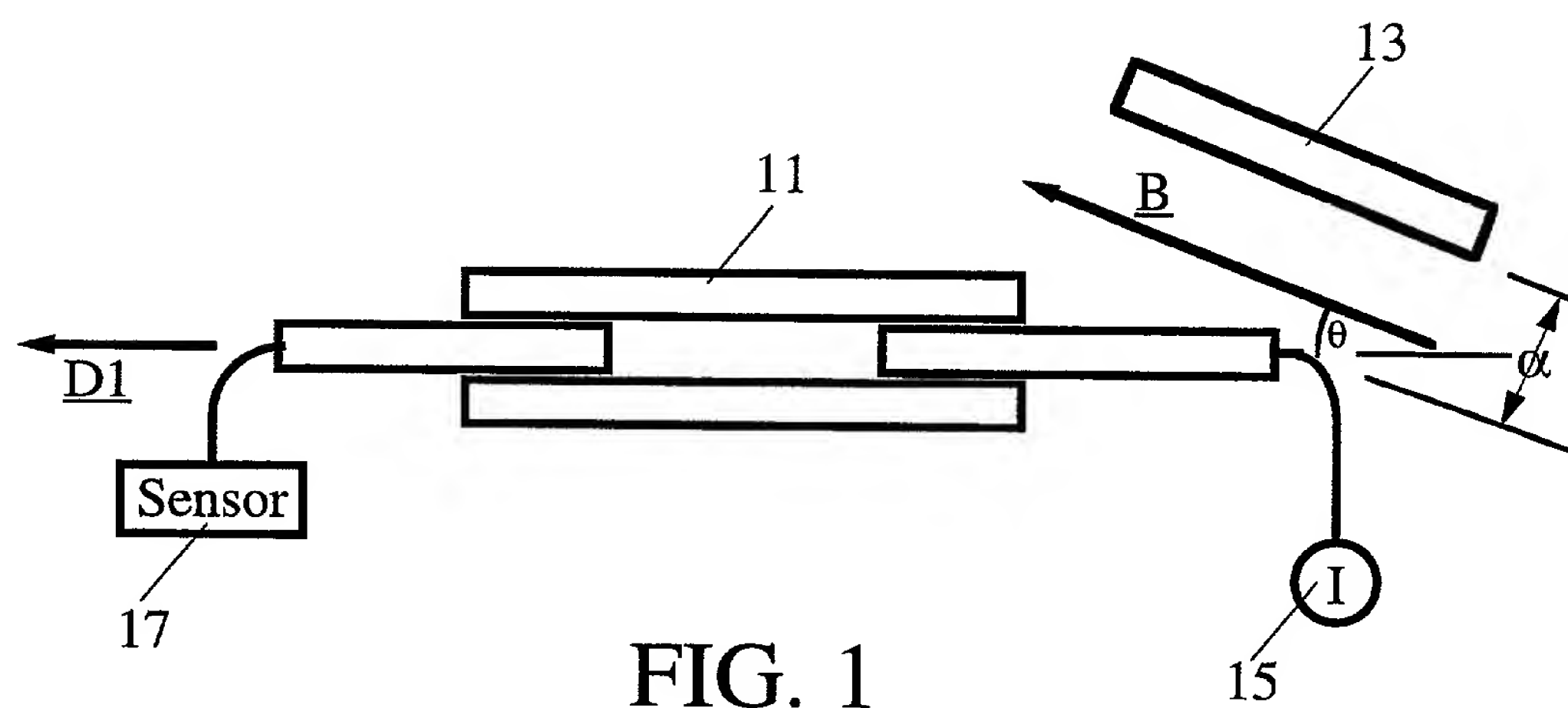
40. The method of claim 38, further comprising the step of arranging for said sensed voltage to be in said second selected range when (i) said attachment mechanism is rotated about said attachment direction by at least a selected threshold angle or (ii) said attachment mechanism is translated in said attachment direction by at least a selected threshold distance.

41. The method of claim 38, further comprising the step of transmitting a selected signal when said at least one of: said current is in said first selected range and said voltage is in said second selected range.

42. The method of claim 38, further comprising the step of drawing said attachment mechanism from a group consisting of a bolt, a screw and a friction-generating nail, and said attachment direction is chosen to be approximately a longitudinal direction of a shaft of the bolt, screw or nail.

Abstract of the Invention

System and method for detecting an unauthorized movement of a communications or meter device, such as a meter that monitors and communicates a measure of use of energy or some other metered quantity (electrical, gas, water, etc.), to prevent meter tampering or removal. A bolt, screw, nail or other attachment mechanism, used to attach the device to a selected stationary or movable object, is provided with a permanent magnet having a selected magnetic field direction that can be transverse to, a selected attachment mechanism direction (e.g., transverse to a bolt shaft direction). A field-activated magnetic switch, such as a reed switch or a Hall effect switch, having a selected switch direction is located near the permanent magnet. If a user attempts to remove, or tamper with the position of, the communications device, by rotating or translating the attachment mechanism, the direction and/or magnitude of the magnetic field changes sufficiently to switch the switch from a first state (normal) to a second state (alarm), and an alarm signal is generated. In a second embodiment, a plunger connected to a micro switch is moved by a contact portion of an attachment mechanism as the attachment mechanism rotates or translates. In a third embodiment, the attachment mechanism is provided with an electrically conducting part and a non-conducting part, and a current-sensing or voltage-sensing circuit is movably connected to the mechanism at two spaced apart locations.



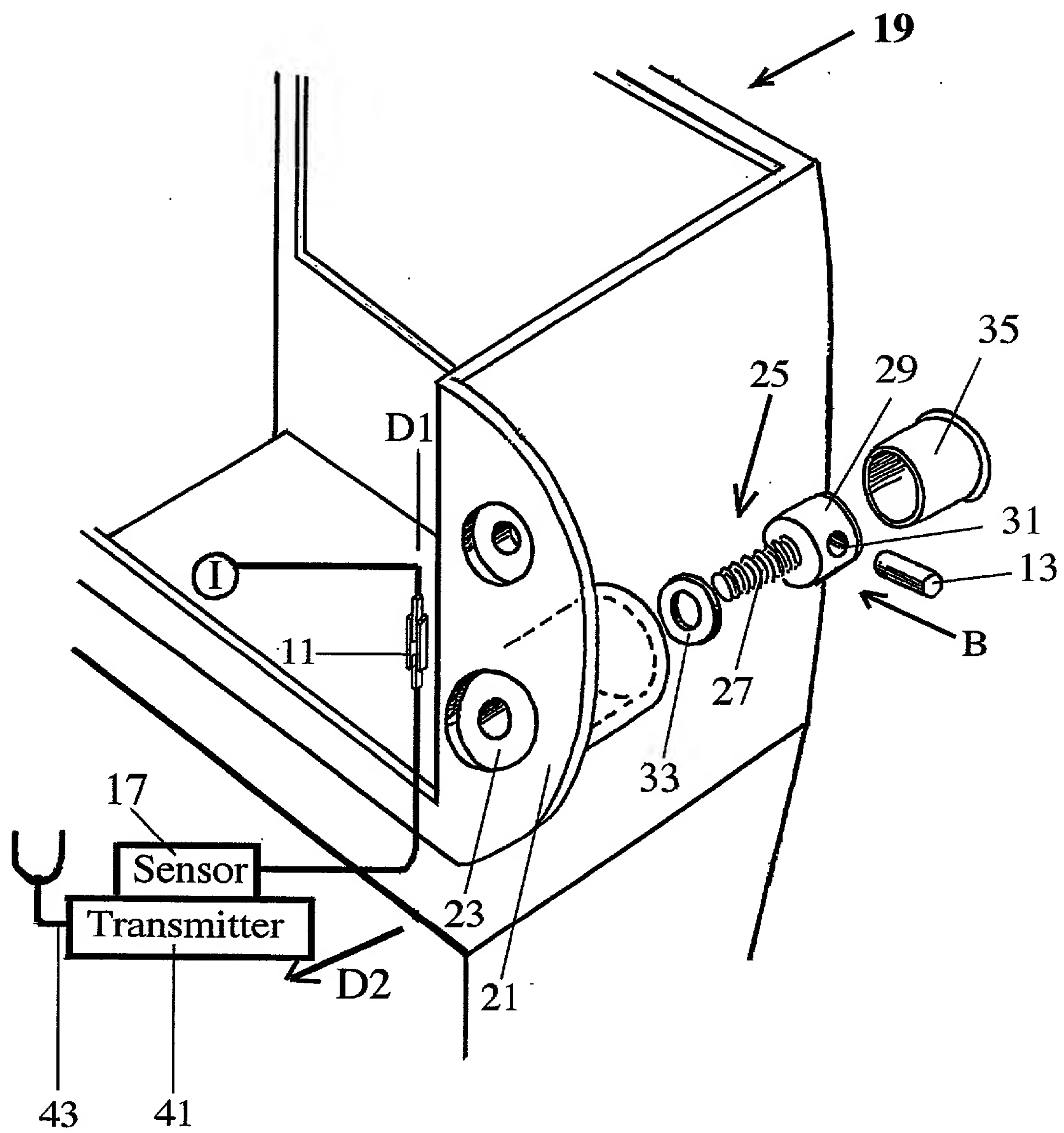


FIG. 2

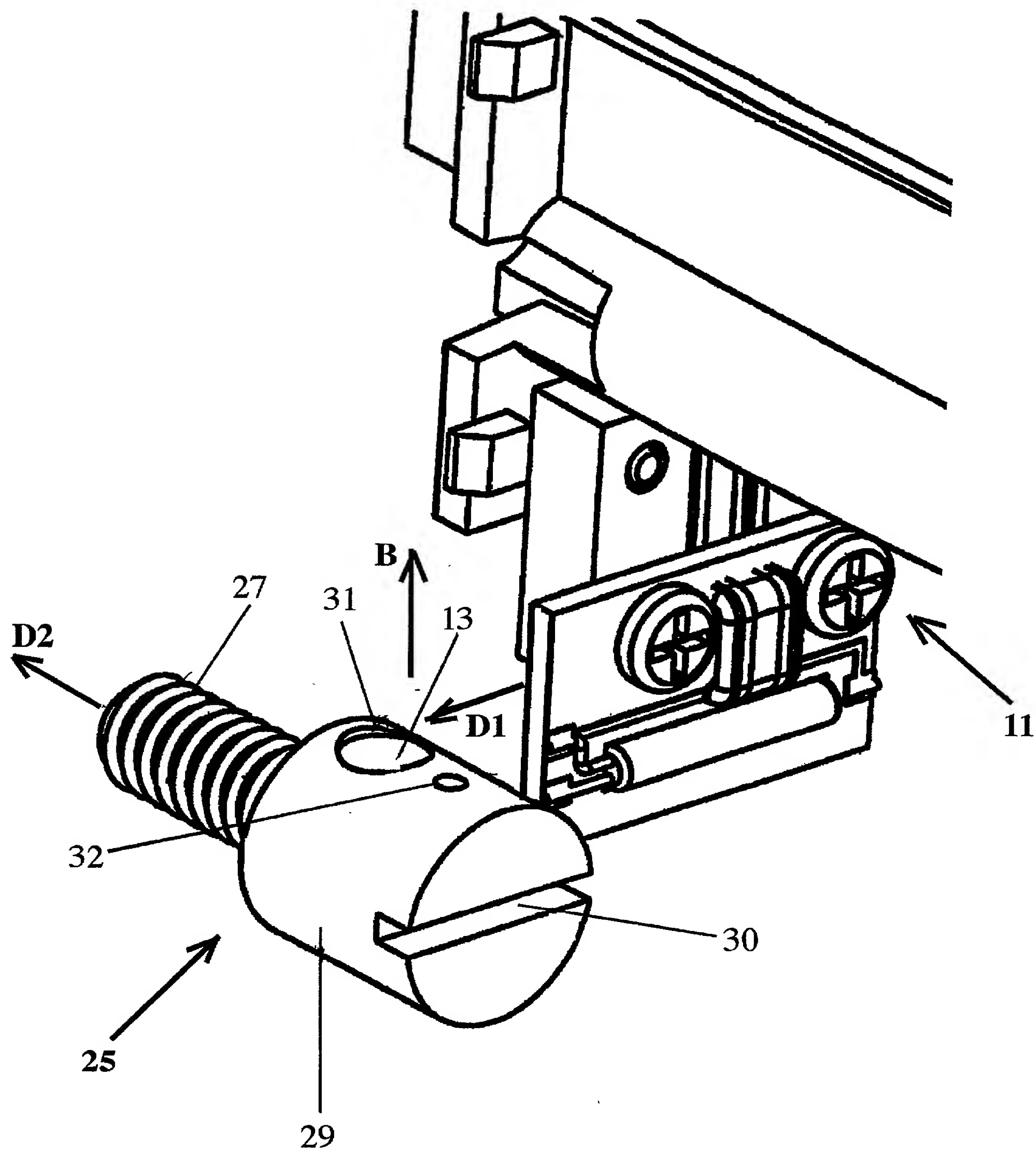


FIG. 3

19

55

59

63

53

61

43

41

Transmitter

D2

This diagram shows an exploded perspective view of a device 19. The device is a rectangular enclosure with a hinged lid. Internal components include a transmitter (labeled 'Transmitter') mounted on a bracket 43, which is attached to a base plate 41. A component 53 is shown in the center, with a label 'D2' pointing to it. Other components include 55, 59, 61, and 63. Mounting hardware such as screws and a bolt are also shown.

FIG. 4

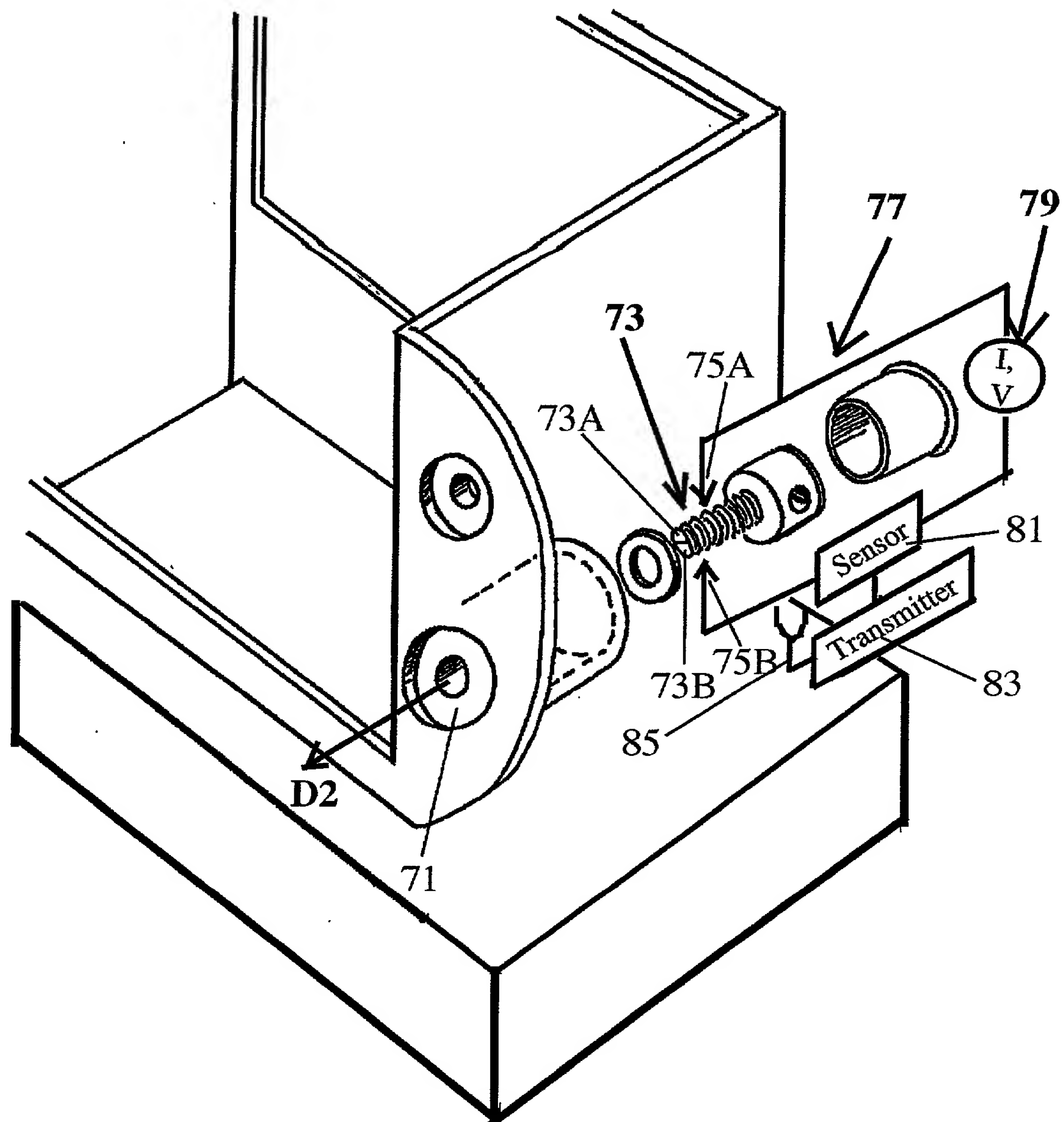


FIG. 7

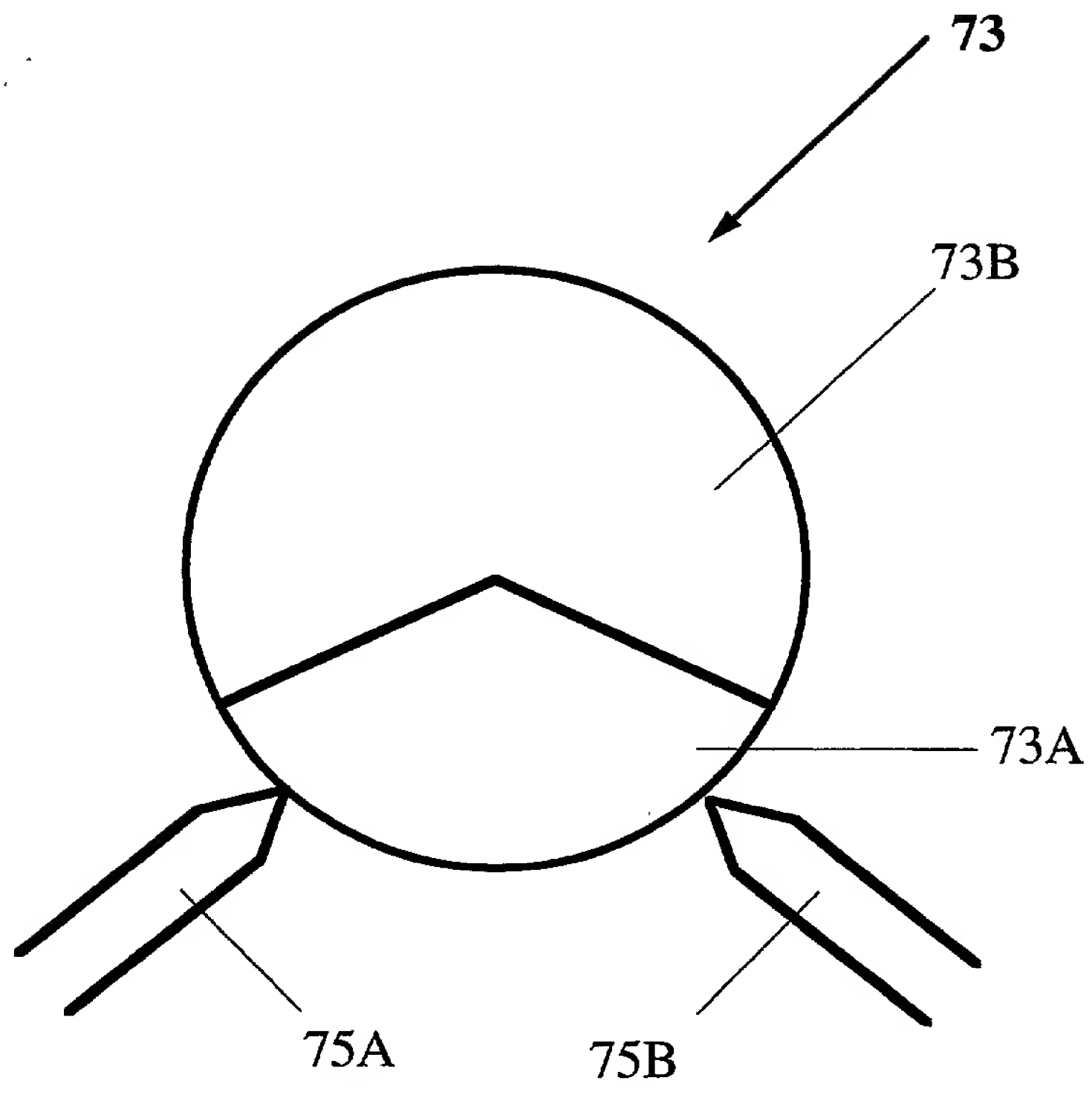


FIG. 8

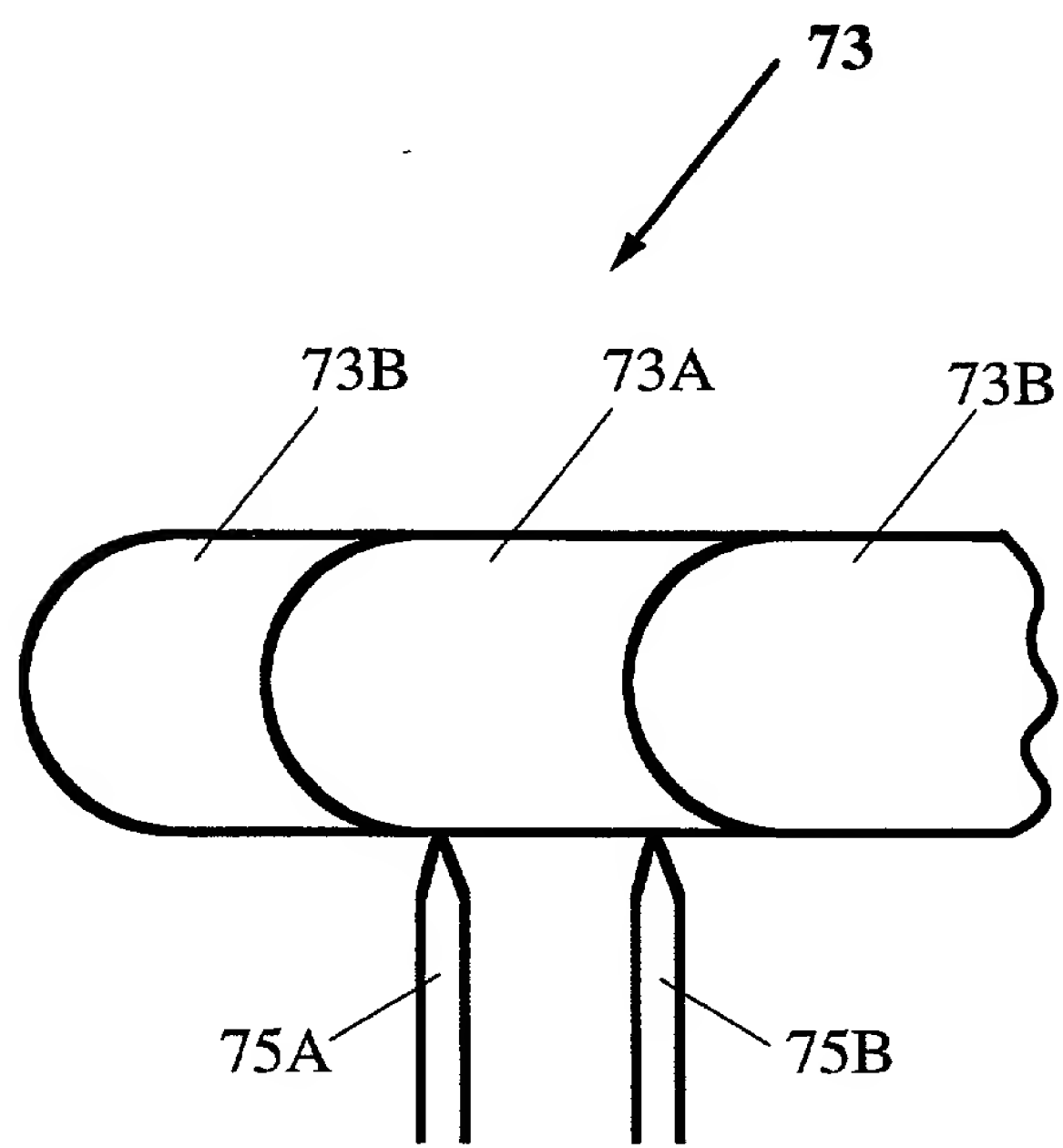


FIG. 9

DECLARATION AND POWER OF ATTORNEY

Original Application

As below named inventor, I declare that I have reviewed and understand the contents of the specification, including the claims, as amended by any amendment specifically referred to in this Declaration, that the information given herein is true, that I believe that I am the original, first and joint inventor of the invention entitled:

TAMPER DETECTION MECHANISM

which is described and claimed in:

X the attached specification or
the specification in application Serial No. _____ filed _____.

The present application is a continuation-in-part of Prior Application Serial No. _____ filed _____ and may be considered to disclose and claim subject matter in addition to that disclosed in the Prior Application, and I hereby claim the benefit of 35 U.S.C. Section 120.

that I acknowledge my duty to disclose information in accordance with 37 C.F.R. Section 1.56 and defined on the attached sheet, which is material to the examination of this application, that I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or more than one year prior to this application, or in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application and that as to applications for patent or inventor's certificate filed by me or my legal representatives or assigns in any country foreign to the United States of America, the earliest filed foreign application(s) filed within twelve months prior to the filing date of this application and all foreign applications filed more than twelve months prior to the filing date of this application, if any, are identified below.

CHECK APPROPRIATE BOX

X No earlier-filed foreign applications.

____ Requirement information as to foreign applications filed prior to filing date of this application is on page ____ attached hereto and made a part hereof.

[illegible]

Robert P. Sabath, Reg. No. 29,107, Bobby K. Truong, Reg. No. 37,499, John F. Schipper, Reg. No. 26,994, and Stanley N. Protigal, Reg No. 28,657, of the firm Sabath & Truong.

DIRECT TELEPHONE CALLS TO

Robert P. Sabath

(408) 293-9934

Fax: (408) 293-2183

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Section 1.56 Duty to Disclose Information Material to Patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by Sections 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applications to carefully examine:

- (1) prior art cited in search report as a foreign patent office in a counterpart application, and
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or
- (2) It refutes, or is inconsistent with, a position the application takes in:
 - (i) opposing an argument of unpatentability relied on by the Office, or
 - (ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any considerations given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

- (1) Each inventor named in the application;
 - (2) Each attorney or agent who prepares or prosecutes the application; and
 - (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.
- (d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent or inventor.